
Biological vs. Nuclear Terrorism: a Spectrum of Contrasts

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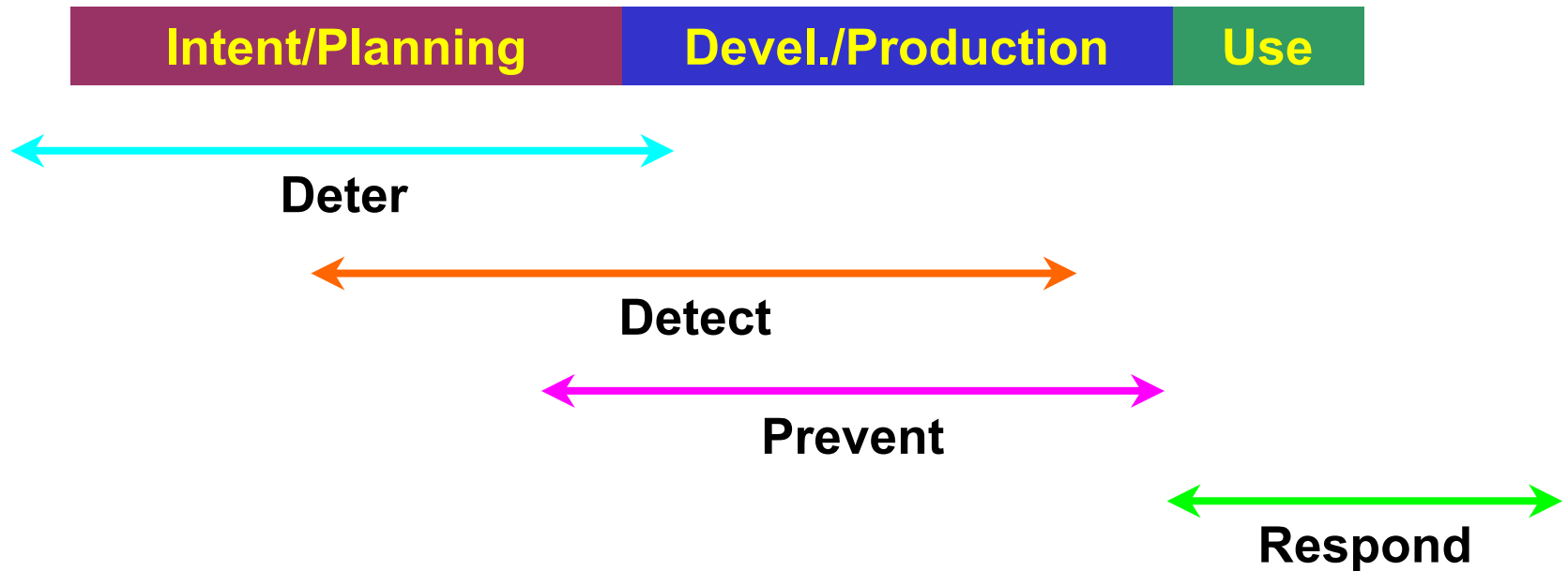
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Biological and nuclear terrorism contrast at all stages



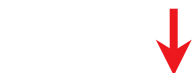


Nuclear production presents a vastly higher technology barrier and detection profile



Nuclear

Uranium mining



Low enrichment



High enrichment



Weapon design, engineering



Weapon fab



Delivery

Thousands of people

Reactors



Pu production



Pu extraction



Dispersion device



Delivery

High explosives

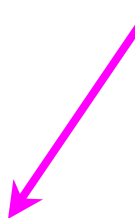


Biological

Seed sample
(lab or natural)



Bio-reactor/
incubator



Liquid

Dryer



Powder



Dispersal
mechanism

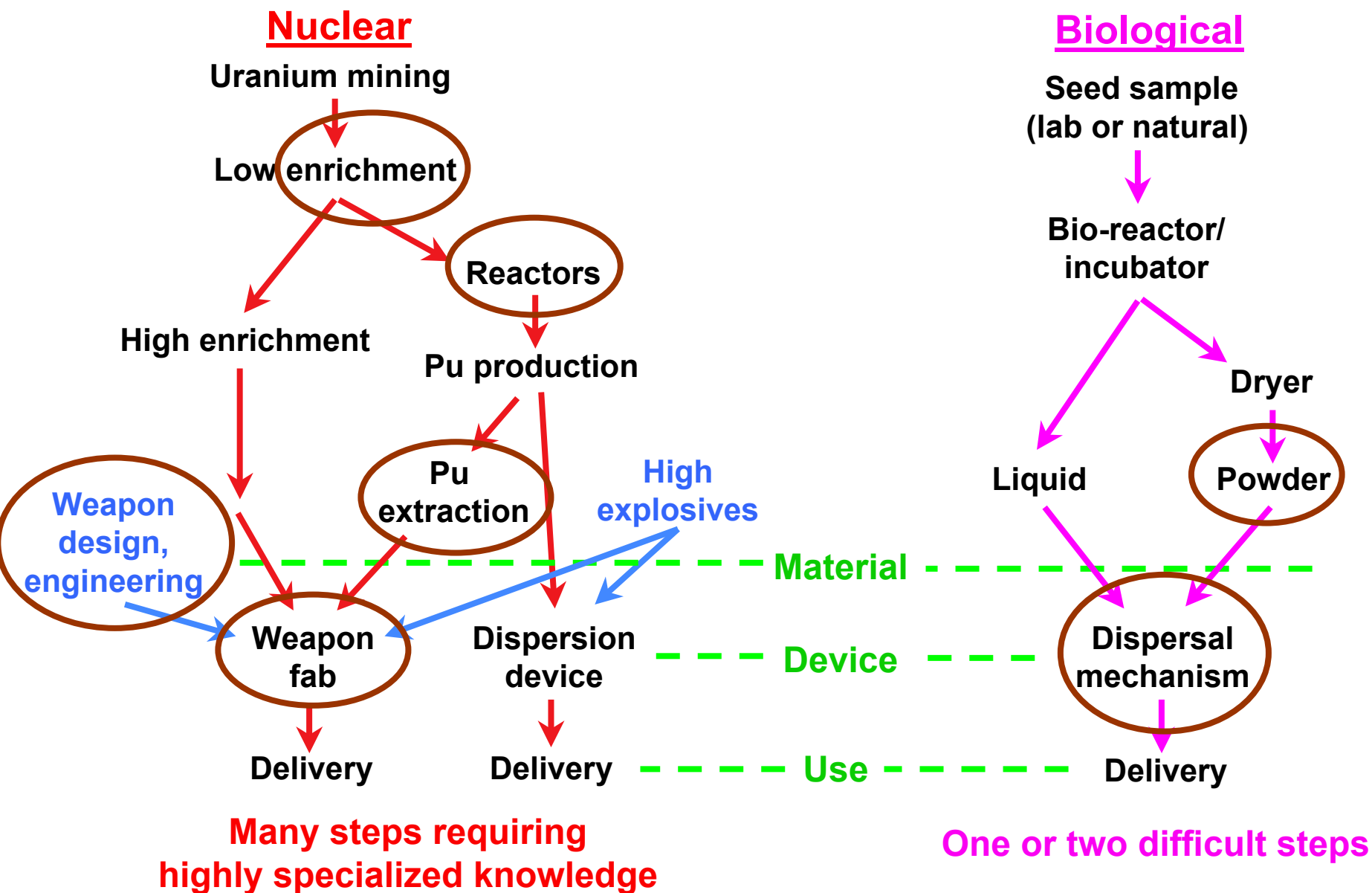


Delivery

Few people, possibly 1

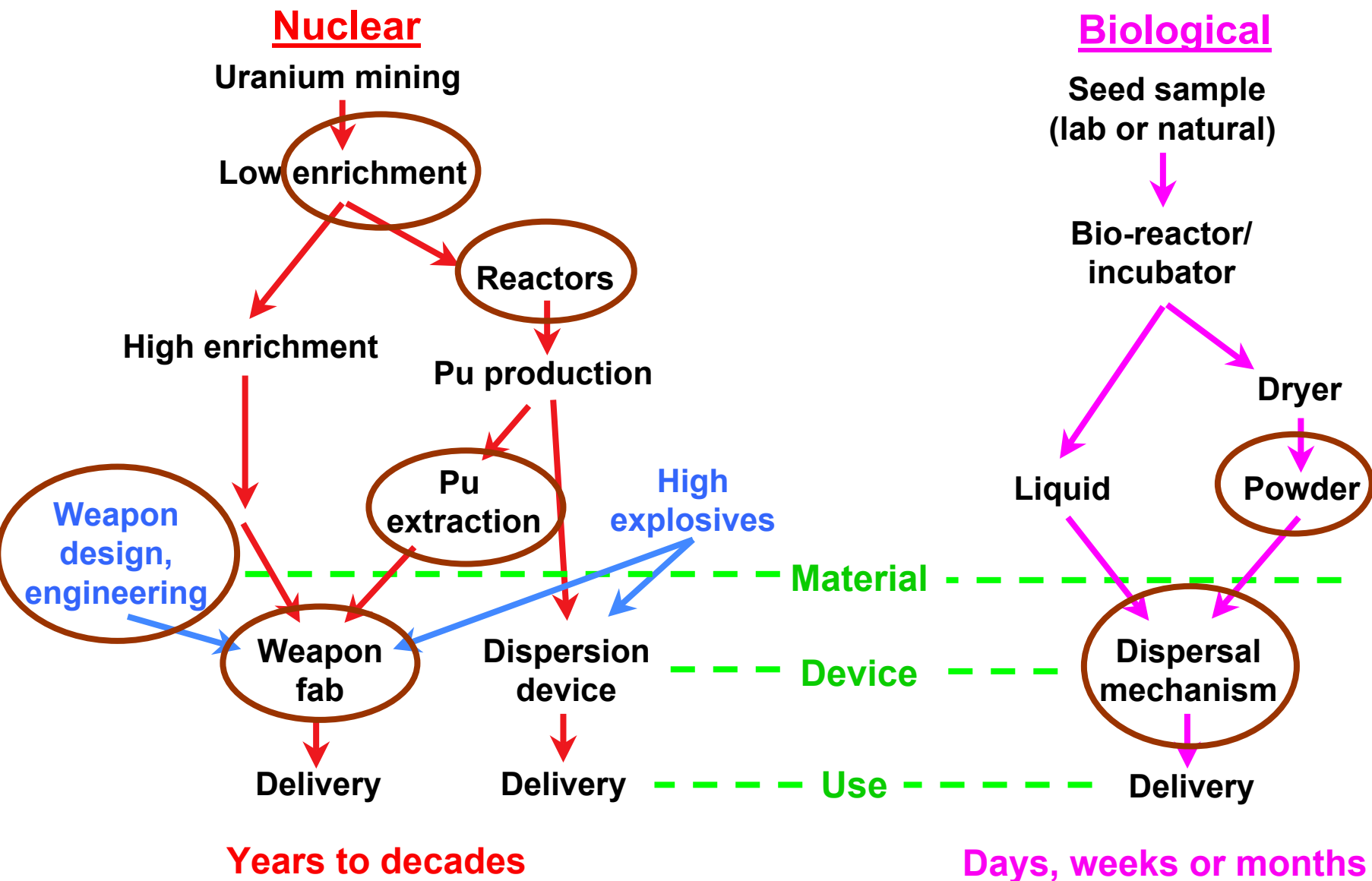


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Material protection, control & accountability requires qualitatively different approaches



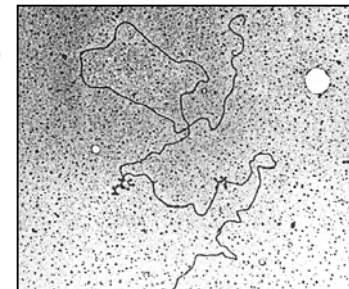
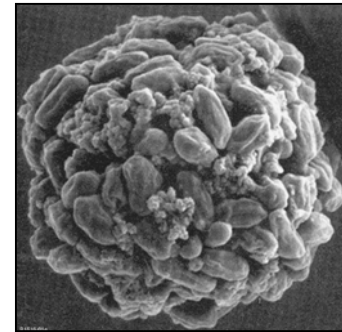
	<u>Nuclear</u> (fraction of device)	<u>Biological</u> (Seed sample, lab or natural)
Minimum quantity of concern	ounces	< μgm
Portal Detectability	high	undetectable
Q_{\min} relative to MUF	significant	negligible
No. of sources	few hundred	tens of thousands +
<u>Effective controls</u>	<i>portal detection material accountability personnel reliability</i>	<i>personnel reliability</i>



Detection: a capability underpinning MPC&A, incident response and clean-up



- **Culture**
 - Grow organisms, often under alternative chemical conditions
 - “Gold standard” for organism identification
 - Built-in viability determination
 - Some quantitation
- **Protein detection (“antibody assays”)**
 - Most common method of rapid testing
 - Easy to perform with minimal training
 - Significant detection threshold (false negatives)
 - Significant cross-reactivity (false positives)
- **DNA detection**
 - Low detection threshold (potentially single organisms)
 - Very high specificity (few to no false-positives)
 - Rough quantitation
 - Requires trained personnel and specialized equipment





Detecting and quantifying biological materials presents significant challenges



Nuclear

Biological

**Accuracy,
sensitivity**

**Accurate for all
amounts of
importance**

Significant uncertainty

- semi-quantitative
- false positives
- false negatives
- presence \neq viability

Speed

**Real-time for quick tests
hours for definitive**

**Hours for quick test,
1 - 3 days for definitive**

Universality

**Minor variations
for different forms**

**Assays specific for
each organism,
common hardware**

Forensics

from isotope mix

**From detailed
DNA analysis**

Health effects considerations for exposed individuals are also qualitatively different

Nuclear

Smooth variation
with exposure
from no health risk
to fatal

Limited individual
susceptibility variation

Exposures presenting
health risk easily detectable

Biological

Trimodal/bimodal
outcomes of exposure:



Significant individual
variability

Lethal dose
potentially undetected

Medical response has much higher value for a biological attack

Nuclear

Health risk well bounded in geography and time

Readily definable categories

- untreatable
- treat
- reassure and release

Medical intervention useful only for small fraction of cases

Medical treatment not particularly time-urgent

Biological

Boundaries much less certain, especially for contagious disease

Initially bimodal

- exposed
- unexposed

Prompt medical intervention likely very effective for many victims and to limit spread

High payoff for early treatment and containment

Contamination: predictable versus controlable

Nuclear

**Decay rates known
with exquisite
precision and
absolutely fixed**

**A few measurements
and simple calculations
give total decay rate**

**Never eliminated,
strategy is to
contain, isolate**



Biological

**Decay rate is
uncertain, variable,
and can be changed**

**Repeated measurement
is the only way
to know for sure**

**Dead is dead,
100% clean-up
is possible . . .**

**Except for
animal reservoirs**

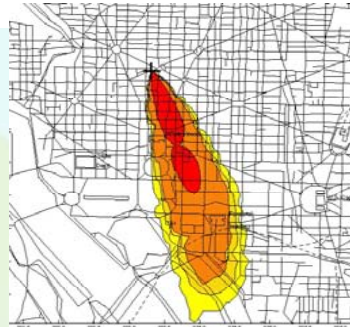
Decontamination strategies are driven by decay, detection, & health effect differences

Nuclear/Radiation

Relatively easy to characterize geographically

Detection is straightforward, know residual contamination levels & risks very accurately

Accurate forecast of time evolution of hazard



Biological

Difficult to bound geographically with high confidence

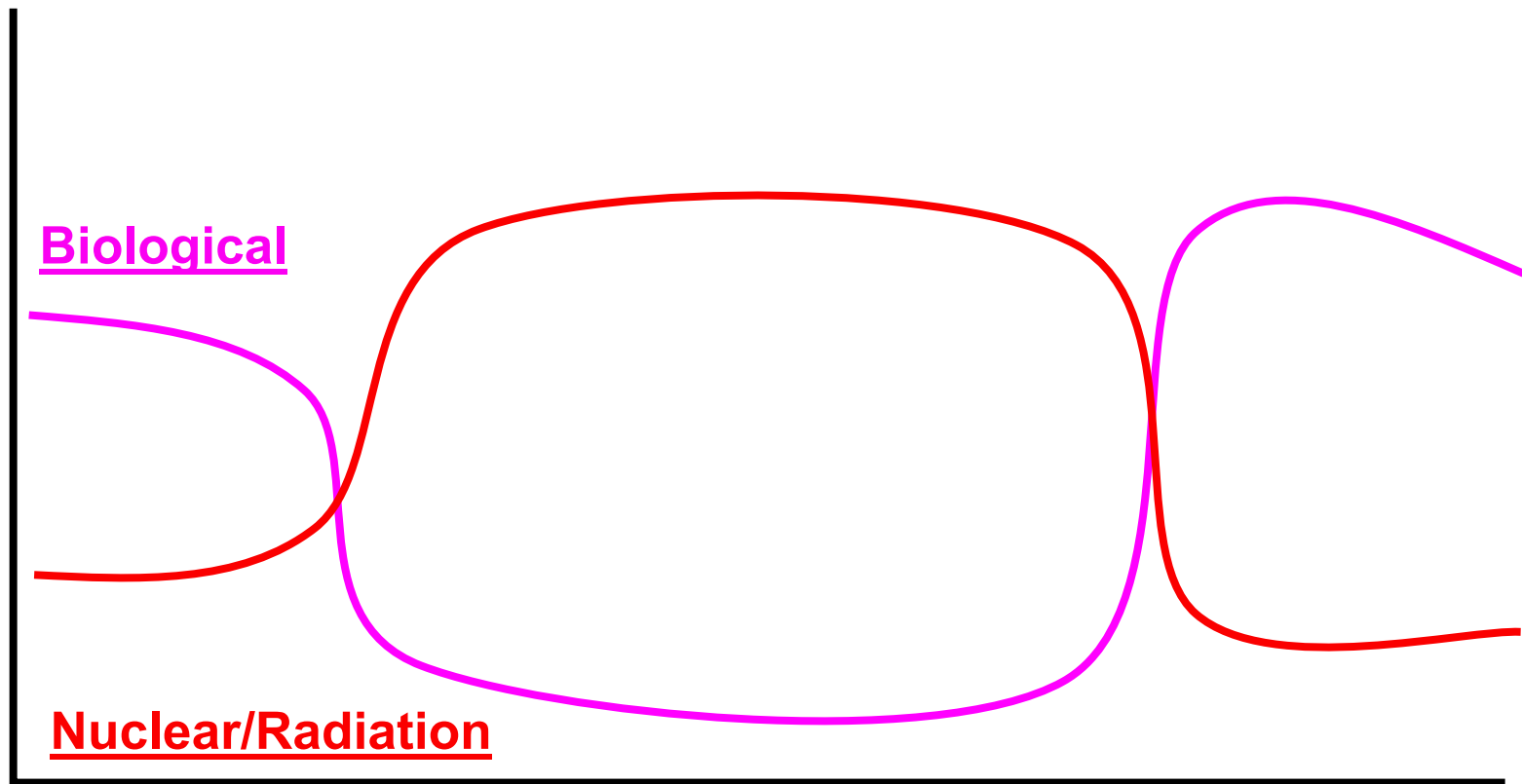
**Detection is challenging
“Clean” must be essentially 100%—no residual agent**

Rates of decay, time evolution quite uncertain

Natural sterilization is effective in many cases



Investment strategies are almost opposite for nuclear versus biological terrorism



Deter

Detect

Prevent

Respond